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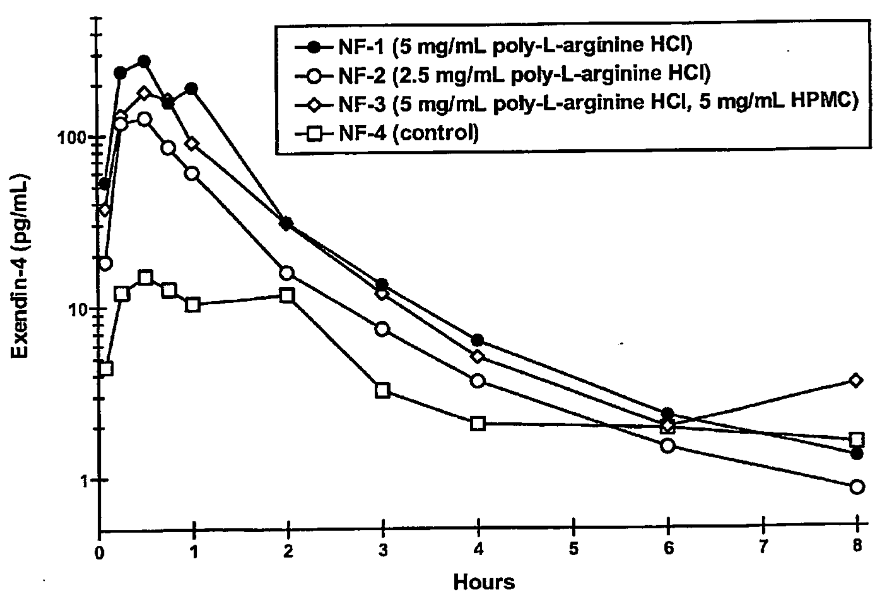
[Continued on next page]

(54) **Title:** NOVEL METHODS AND COMPOSITIONS FOR ENHANCED TRANSMUCOSAL DELIVERY OF PEPTIDES AND PROTEINS



(57) **Abstract:** Provided are methods and compositions for enhancing the transmucosal absorption of bioactive peptides and proteins. More particularly, the invention provides compositions for enhancing the transmucosal absorption of bioactive peptides and proteins, such as exendin-4, PYY, PYY_{3-36}, and GLP-1 and their analogs and derivatives, wherein the compositions comprise an absorption enhancing mixture of a cationic polyamino acid and a buffer that is compatible with the polyamino acid. Also provided are methods for enhancing the transmucosal absorption and bioavailability of bioactive peptides and proteins using such compositions.

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NOVEL METHODS AND COMPOSITIONS FOR ENHANCED TRANSMUCOSAL DELIVERY OF PEPTIDES AND PROTEINS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Patent Application Serial No. 60/474,233, filed May 30, 2003, which is incorporated herein by reference in its entirety for all purposes.

FIELD OF INVENTION

The present invention relates generally to the field of drug delivery. More particularly, the present invention relates to novel methods and compositions for the enhanced transmucosal delivery of bioactive peptides and proteins.

BACKGROUND

The administration of therapeutically active peptides and proteins has generally been limited to injection due to difficulties in achieving the required bioavailability via alternative, less invasive routes such as oral, transmucosal, or transdermal. For instance, administration by ingestion can result in chemical and enzymatic degradation in the gastrointestinal tract, resulting in a substantial loss of activity and low bioavailability. Transmucosal delivery through absorptive mucous membranes such as oral, buccal, sublingual, eye, nasal, pulmonary, rectal, and vaginal membranes, on the other hand, has the advantage of being noninvasive and of bypassing hepato/gastrointestinal clearance (at least initially). Peptides and proteins, however, are generally not well absorbed through mucosae because of their molecular size and hydrophilicity. In general, enzyme inhibitors and absorption enhancers need to be coadministered for successful transmucousal delivery of bioactive peptides and proteins.

Classes of absorption enhancers used for transmucosal delivery include bile salts and their derivatives, taurodihydrofusidates, mono- and polycarboxylic acids, cyclodextrins, surfactants (especially non-ionic), chelating agents, cationic polymers, lipids and phospholipids (see Davis and Illum, *Clin Pharmacokinet.*, 42:1107-1128, 2003 for a review). Each of these agents exerts its enhancing effects by a different mechanism, and many have been associated with various degrees of adverse effects.

Nonetheless, these enhancers have been demonstrated to enhance the absorption and, consequently, bioavailability of peptides and proteins across the mucous membrane.

The nasal cavity provides an attractive route for peptide and protein delivery because of its relatively high permeability and ease of administration. Nasal spray compositions containing a chelating agent such as disodium ethylenediaminetetraacetate, or bile salt have been shown to enhance the absorption of nona- and deca-peptides having LHRH agonist or antagonist activity (U.S. Patent No. 4,476,116 and 5,116,817). A combination of bile salt and dimethyl-β-cyclodextrin has been used to enhance the nasal absorption of parathyroid hormones (U.S. Patent No. 5,977,070). Lysophospholipids, acylcarnitines and polyoxyethylene(20) sorbitan monooleate (Tween® 80) have also been used as enhancers for the delivery of insulin and calcitonin across mucous membranes (U.S. Patent Nos. 5,804,212 and 6,440,392). The cationic polysaccharide chitosan, used as powder, nanoparticle, or in solution, has been demonstrated to enhance mucosal absorption of insulin, other peptides and proteins, and vaccines (U.S. Patent No. 6,391,318; Dyer et al., *Pharm. Res.*, 19:998-1008, 2002; Illum et al., *Pharm. Res.*, 11:1186-1189, 1994; Fernandez-Urrusuno et al., *Pharm. Res.*, 16:1576-1581, 1999). Additionally, bioadhesive agents, such as carbomers and polycarbophil, have been used to increase the residence time and therefore the bioavailability of insulin from a powder dosage form (Callen and Remon, *Controlled Rel.*, 66:215-220, 2000).

The cationic polyamino acid, polylysine, was mentioned in an aerosol formulation for pulmonary and nasal delivery, but no rationale for its function was given (U.S. Patent No. 6,294,153). Another cationic polyamino acid, poly-L-arginine was reported to enhance the absorption of fluorescein isothiocyanate labeled dextran (Nasume et al., *Intl. J. Pharm.*, 185:1-12, 1999), but no bioactive peptides or proteins were investigated. Other applications for potential uses of cationic polyamino acids to improve transmucosal delivery of molecules can be found in US Patent Nos. 5,554,388 and 5,788,959; Japanese Patent Applications 1998095738A, 2000281589A; McEwan et al., *Biochim. Biophys. Acta*, 1148:51-60, 1993; Uchida et al., *Exp. Lung Res.*, 22:85-99, 1996; Natsume et al., *Drug Deliv. Systems*, 14:21-25, 1999; Miyamoto et al, *Intl. J. Pharma.*, 226:127-138, 2001; Miyamoto et al., *Eur. J. Pharma Biopharma.*, 52:21-30, 2001; Ohtake et al., *J. Controlled Res.*, 82:263-275, 2002 and Ohtake et al., *Pharm. Res.*, 20:1838-1845, 2003. Many of these papers describe the use of cationic polyamino acids to deliver marker molecules such a labeled dextran

rather than proteins or peptides. Thus, there remains a need for improved absorption enhancers for use in the transmucosal delivery of bioactive peptides and proteins.

SUMMARY

Among the several aspects of the invention is provided a pharmaceutical composition for the transmucosal administration of a bioactive peptide or protein of interest comprising the bioactive peptide or protein of interest, an absorption enhancing amount of a cationic polyamino acid, and a compatible buffer that does not cause precipitation of the cationic polyamino acid and has a mono-anionic or neutral net charge at the pH of the composition. The composition is further characterized in that the transmucosal absorption of the bioactive protein or peptide of interest is increased relative to the absorption of the protein or peptide in the absence or substantial absence of the cationic polyamino acid. In one embodiment the absorption of the bioactive protein or peptide is increased at least 2-fold, while in other embodiments it is increased at least 5-fold or at least 10-fold. In one embodiment, the pH of the composition ranges from about pH 3.0 to about pH 6.0, while in another embodiment the pH is between about pH 4.0 and about pH 5.0. In still a further embodiment, the pH of the composition is about pH 4.5. In another embodiment, the compatible buffer comprises glutamic acid, while in other embodiments the compatible buffer comprises acetic acid or ε-aminocaproic acid. In a further embodiment, the cationic polyamino acid comprises poly-arginine, while in other embodiments the cationic polyamino acid is poly-histidine, poly-lysine or any combination of poly-arginine, poly-histidine and poly-lysine. In one embodiment the cationic polyamino acid or acids has an average molecular weight of between about 10kDa and about 200kDa. In another embodiment, the cationic polyamino acid has an average molecular weight of between about 100kDa and 200kDa. In still a further embodiment, the cationic polyamino acid has an average molecular weight between about 140kDa and about 150kDa, while in yet another embodiment, the cationic polyamino acid has an average molecular weight of about 141kDa.

In other embodiments, the composition further comprises a tonicifying agent, a viscosity-increasing agent, a bioadhesive agent, a preservative or any combination of a tonicifying agent, a viscosity-increasing agent, a bioadhesive agent, and a preservative. In one embodiment the tonicifying agent used is selected from sodium chloride, mannitol, sucrose, glucose and any combination of sodium chloride,

mannitol, sucrose and glucose. In another embodiment in which a viscosity-increasing agent is used, the agent can be selected from hydroxypropyl cellulose, hydroxyproply methylcellulose, methylcellulose with an average molecular weight between about 10 and about 1500 kDa, starch, gums and any combination of the listed viscosity increasing agents. In another embodiment, in which a bioadhesive agent is used, the bioadhesive agent can be selected from carbomer, polycarbophil and any combination of carbomer and polycarbophil. In embodiments utilizing a preservative, the preservative can be selected from phenylethyl alcohol, methylparaben, ethylparaben, propylparaben, butylparaben, chlorbutanol, benzoic acid, sorbic acid, phenol, m-cresol, alcohol, and any combination of the preservatives listed herein.

In certain embodiments, the bioactive protein or peptide is an exendin, an exendin analog or an exendin derivative described herein or known in the art including polymer-modified compounds thereof. In various embodiments the bioactive peptide or protein is exendin-3, exendin-4 or one of the analogs or derivatives described by any of Formulas I, II or III or listed in Table 1. In specific embodiments, the exendin analogs or derivatives include but are not limited to exendin-4 acid, exendin-4 (1-30), exendin-4 (1-30) amide, exendin-4 (1-28) amide, ^{14}Leu, ^{25}Phe exendin-4 amide, and ^{14}Leu, ^{25}Phe exendin-4 (1-28) amide.

In other embodiments, the bioactive protein or peptide is GLP-1 or any of the GLP-1 analogs and derivatives listed herein or known in the art including polymer-modified compounds thereof. In still another embodiment, the bioactive protein or peptide is a PYY peptide or an analog or a derivative of a PYY peptide listed herein or known in the art including polymer-modified compounds thereof. In yet another embodiment, the bioactive protein or peptide is amylin or an analog or a derivative of amylin listed herein or known in the art including polymer-modified compounds thereof.

One embodiment provides a pharmaceutical composition for transmucosal administration of a bioactive peptide or protein of interest comprising about 0.01% to about 5.0% (w/v) of the bioactive peptide or protein of interest, such as an exendin, a GLP-1, an amylin, or a PYY peptide as well and analogs of, derivatives of, and polymer-modified exendin, a GLP-1, amylin, and PYY; about 0.01% to about 1.0% (w/v) of a cationic polyamino acid having a molecular weight between about 10 kDa and about 200 kDa; such as poly-arginine, poly-histidine and poly-lysine; and about 0.01% to about 10.0% (w/v) of a compatible buffer, that at between about pH 4.0 and

about 5.0 does not cause precipitation of the cationic polyamino acid, and has a mono-anionic or neutral net charge. Additionally, the transmucosal absorption of the bioactive peptide or protein is increased relative the absorption of said bioactive peptide or protein in the absence of said cationic polyamino acid.

In a particular embodiment is provided a pharmaceutical composition for transmucosal administration comprising about 0.5% (w/v) of exendin-4; about 0.5% (w/v) of poly-L-arginine hydrochloride having an average molecular weight of about 141 kDa; about 0.72% (w/v) sodium chloride; and about 0.56% monosodium glutamate, monohydrate (w/v) at a pH of about 4.5.

In another particular embodiment is provided a pharmaceutical composition for transmucosal administration comprising about 0.5% (w/v) of exendin-4; about 1.0% (w/v) of poly-L-arginine hydrochloride having an average molecular weight of about 141 kDa; about 0.72% (w/v) sodium chloride; and about 0.56% monosodium glutamate, monohydrate (w/v) at a pH of about 4.5.

Further embodiments provide a method for transmucosal administration of a bioactive peptide or protein comprising contacting a mucosal surface with any of the pharmaceutical compositions described herein for a time sufficient for a therapeutically effective amount of the bioactive peptide or protein of interest to cross the mucosa such that the transmucosal absorption of the bioactive protein or peptide is increased relative to the absorption of the bioactive protein or peptide in the absence or substantial absence of a cationic polyamino acid, such as in the compositions described herein. In one embodiment, the bioactive peptide or protein is an exendin, an exendin analog, or an exendin derivative described herein or known in the art including polymer-modified compounds thereof. In another embodiment, the bioactive peptide or protein is GLP-1, a GLP-1 analog or a GLP-1 derivative described herein or known in the art including polymer-modified compounds thereof. In still another embodiment, the bioactive peptide or protein is a PYY peptide, a PYY peptide analog, or a PYY peptide derivative described herein or known in the art including polymer-modified compounds thereof. In yet another embodiment, the bioactive peptide or protein is amylin, an amylin analog, or an amylin derivative described herein or known in the art including polymer-modified compounds thereof.

Also provided are methods for increasing the bioavailability of a bioactive protein or peptide of interest comprising administering to a subject any of the pharmaceutical compositions described herein for a time sufficient to allow

transmucosal absorption of the protein or peptide such that the bioavailability of the bioactive peptide or protein of interest is greater than when the peptide or protein is administered alone, that is in the absence or substantial absence of the cationic polyamino acid. In one embodiment, the method is used to increase the bioavailability of an exendin, an exendin analog, or an exendin derivative described herein or known in the art including polymer-modified compounds thereof. In another embodiment, the method is used to increase the bioavailability of GLP-1, a GLP-1 analog, or a GLP-1 derivative described herein or known in the art, including polymer modified compounds thereof. In yet another embodiment, the method is used to increase the bioavailability of a PYY peptide, a PYY analog, or a PYY derivative described herein or known in the art including polymer-modified compounds thereof. In still another embodiment, the method is used to increase the bioavailability of amylin, an amylin analog, or an amylin derivative described herein or known in the art including polymer-modified compounds thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 depicts the bioavailability enhancement of three exendin-4 aqueous solutions containing poly-L-arginine with or without hydroxypropyl methylcellulose as compared to a control exendin-4 solution without poly-L-arginine. Shown are the pharmacokinetic profiles of exendin-4 in Cynomolgus monkeys (n=3) after intranasal doses normalized to 1 μg/kg.

Figure 2 depicts the area under the plasma curves (AUC) (0-8 hours) of exendin-4 nasal formulations relative to a formulation including 5 mg/mL poly-L-arginine (NF-1). NF-1, NF-2 and NF-3 are the compositions described in Examples 1, 2 and 3, respectively. NF-4 is a control formulation lacking poly-L-arginine.

DETAILED DESCRIPTION

In one aspect, the present invention teaches the design of novel pharmaceutical compositions for the transmucosal delivery of bioactive peptides and proteins. The novel compositions of the invention may be used to effectively deliver bioactive peptides and proteins systemically to the blood subsequent to transmucosal administration.

More particularly, it has now been found that enhanced transmucosal absorption of bioactive peptides and proteins can be achieved when delivered in conjunction with an absorption enhancing composition comprising a cationic polyamino acid and a buffer which is compatible with the cationic polyamino acid.

Generally, peptides and proteins comprise hydrophobic, hydrophilic, and charged regions which are all capable of interaction with other molecules. As such, one of skill in the art may expect that cationic compounds, such as cationic polyamino acids, would interact with the negative charges of the peptides or proteins. Based on precipitation encountered when cationic polyamino acids are formulated with multi-anionic buffers, such interactions may be expected to result in precipitation or inactivity of the cationic polyamino acid as a permeation enhancer. However, it was unexpectedly discovered according to the invention that cationic polyamino acids, particularly when formulated with buffers that avoid interaction and/or precipitation of the polyamino acids with bioactive peptides or proteins, actually act as a transmucosal absorption enhancer. Increases in absorption can be at least 2-fold, at least 5-fold or at least 10 fold greater than that obtained in the absence or substantial absence of the cationic polyamino acid. The extent of the enhanced absorption exceeds what would be normally expected with traditional cationic absorption enhancers such as chitosan. Further, this enhanced transmucosal absorption results in an unexpected improvement in bioavailability of greater than 2-fold, greater than 5-fold or greater than 10-fold compared to transmucosal delivery in the absence or substantial absence of the absorption enhancing compositions described herein. It will be apparent to those skilled in the art that the exact increase in absorption or bioavailability may vary with known factors such as the size of the protein, the method of administration, the concentration of the bioactive protein or peptide, the amount of composition applied, and the particular mucosal surface to which the composition is applied.

Other aspects relate to methods for enhancing the transmucosal absorption of bioactive peptides and proteins, and methods for improving the bioavailability of bioactive peptides and proteins when administered via transmucosal delivery. The pharmaceutical compositions can be delivered to the mucous membrane absorption site by any means known in the art, for example, dropping or spraying from a bottle into the eye, nasal, buccal, or sublingual cavity; by aerosolizing from an inhaler into the pulmonary region; as well as by applying a tablet, capsule, permeable/soluble

matrix, or other known dosage forms to the buccal, sublingual, rectal, or vaginal areas.

The pharmaceutical compositions described herein that provide enhanced transmucosal absorption generally comprise a bioactive peptide or protein in combination with an absorption enhancing mixture comprising a cationic polyamino acid and a buffer that is compatible with the cationic polyamino acid. Optionally, the pharmaceutical compositions of the invention may also include one or more excipients such as agent(s) to render the solution compatible with body tissue; viscosity-increasing agent(s), bioadhesive agents, preservative(s), and the like.

The bioactive peptides or proteins of the invention include peptides or proteins that are inherently compatible or formulated to be compatible with the cationic polyamino acids of the invention, *i.e.*, those bioactive peptides and proteins which do not interact with or cause precipitation of the cationic polyamino acid when in solution. In one embodiment the peptide or protein has the same net charge as the polyamino acid at the pH of the composition. For example, at the pH of the composition both the protein and the polyamino acid have a net positive charge. In this situation, it is not necessary that the magnitude of the charge be identical, but only that the net charge be the same.

The bioactive peptides or proteins used in the composition can be any bioactive protein or peptide known in the art. In one embodiment the bioactive peptides and proteins comprise exendins, exendin analogs and exendin derivatives. Examples of suitable exendins include exendin-3, exendin-4, exendin-4 acid, exendin-4 (1-30), exendin-4 (1-30) amide, exendin-4 (1-28), exendin-4 (1-28) amide, ^{14}Leu, ^{25}Phe exendin-4 amide, and ^{14}Leu, ^{25}Phe exendin-4 (1-28) amide as well as other bioactive exendins known in the art such as those described in International Patent Application Publication Nos. WO 99/07404, WO 99/25727, WO 99/25728, and WO 01/04156; US Patent Application Publication Nos. US 2003-0087820, US 2002-137666 and US 2003-087821; and US Patent No. 6,528,486, all of which are herein incorporated by reference in their entireties and in particular the exendin-related sequences contained therein.

Exendins that can be used in the compositions disclosed herein include those described by Formula I (SEQ ID No. 3) which is as follows:

Xaa_1 Xaa_2 Xaa_3 Gly Thr Xaa_6 Xaa_7 Xaa_8 Xaa_9 Xaa_{10} Ser Lys Gln Xaa_{14} Glu Glu Glu Ala Val Arg Leu Xaa_{22} Xaa_{23} Xaa_{24} Xaa_{25} Leu Lys Asn Gly Gly Xaa_{31} Ser Ser Gly Ala Xaa_{36} Xaa_{37} Xaa_{38} Xaa_{39}-Z;

where:

Xaa_1 is His, Arg or Tyr;

Xaa_2 is Ser, Gly, Ala or Thr;

Xaa_3 is Asp or Glu;

Xaa_6 is Phe, Tyr or naphthylalanine;

Xaa_7 is Thr or Ser;

Xaa_8 is Ser or Thr;

Xaa_9 is Asp or Glu;

Xaa_{10} is Leu, Ile, Val, pentylglycine or Met;

Xaa_{14} is Leu, Ile, pentylglycine, Val or Met;

Xaa_{22} is Phe, Tyr or naphthylalanine;

Xaa_{23} is Ile, Val, Leu, pentylglycine, tert- butylglycine or Met;

Xaa_{24} is Glu or Asp;

Xaa_{25} is Trp, Phe, Tyr, or naphthylalanine;

Xaa_{31}, Xaa_{36}, Xaa_{37} and Xaa_{38} are independently Pro, homoproline, 3Hyp, 4Hyp, thioproline, N- alkylglycine, N-alkylpentylglycine or N-alkylalanine;

Xaa_{39} is Ser, Thr or Tyr; and

Z is-OH or-NH2

Examples of additional exendins that can be used in the compositions disclosed herein include those described by Formula II (SEQ ID No. 4) which is as follows:

Xaa_1 Xaa_2 Xaa_3 Gly Xaa_5 Xaa_6 Xaa_7 Xaa_8 Xaa_9 Xaa_{10} Xaa_{11} Xaa_{12} Xaa_{13} Xaa_{14} Xaa_{15} Xaa_{16} Xaa_{17} Ala Xaa_{19} Xaa_{20} Xaa_{21} Xaa_{22} Xaa_{23} Xaa_{24} Xaa_{25} Xaa_{26} Xaa_{27} Xaa_{28}-Z_1;

where

Xaa_1 is His, Arg or Tyr;

Xaa_2 is Ser, Gly, Ala or Thr;

Xaa_3 is Ala, Asp or Glu;

Xaa_5 is Ala or Thr;

Xaa_6 is Ala, Phe, Tyr or naphthylalanine;

Xaa_7 is Thr or Ser;

Xaa_8 is Ala, Ser or Thr;

Xaa_9 is Asp or Glu;

Xaa_{10} is Ala, Leu, Ile, Val, pentylglycine or Met;

Xaa_{11} is Ala or Ser;

Xaa_{12} is Ala or Lys;

Xaa_{13} is Ala or Gln;

Xaa_{14} is Ala, Leu, Ile, pentylglycine, Val or Met;

Xaa_{15} is Ala or Glu;

Xaa_{16} is Ala or Glu;

Xaa_{17} is Ala or Glu;

Xaa_{19} is Ala or Val;

Xaa_{20} is Ala or Arg;

Xaa_{21} is Ala or Leu;

Xaa_{22} is Ala, Phe, Tyr or naphthylalanine;

Xaa_{23} is Ile, Val, Leu, pentylglycine, tert-butylglycine or Met;

Xaa_{24} is Ala, Glu or Asp;

Xaa_{25} is Ala, Trp, Phe, Tyr or naphthylalanine;

Xaa_{26} is Ala or Leu;

Xaa_{27} is Ala or Lys;

Xaa_{28} is Ala or Asn;

Z_1 is -OH,

-NH_2,

Gly-Z_2,

Gly Gly-Z_2,,

Gly Gly Xaa_{31}-Z_2

Gly Gly Xaa_{31} Ser-Z_2,

Gly Gly Xaa_{31} Ser Ser-Z_2,

Gly Gly Xaa_{31} Ser Ser Gly-Z_2,

Gly Gly Xaa_{31} Ser Ser Gly Ala-Z_2,

Gly Gly Xaa_{31} Ser Ser Gly Ala Xaa_{36}-Z_2,

Gly Gly Xaa_{31} Ser Ser Gly Ala Xaa_{36} Xaa_{37}-Z_2, or

Gly Gly Xaa_{31} Ser Ser Gly Ala Xaa_{36} Xaa_{37} Xaa_{38}-Z_2;

Xaa_{31} Xaa_{36}, Xaa_{37} and Xaa_{38} are independently Pro, homoproline, 3Hyp, 4Hyp, thioproline, N-alkylglycine, N-alkylpentylglycine or N-alkylalanine; and

Z_2 is-OH or-NH_2;

provided that no more than three of Xaa_3, Xaa_5, Xaa_6, Xaa_8, Xaa_{10}, Xaa_{11}, Xaa_{12}, Xaa_{13}, Xaa_{14}, Xaa_{15}, Xaa_{16}, Xaa_{17}, Xaa_{19}, Xaa_{20}, Xaa_{21}, Xaa_{24}, Xaa_{25}, Xaa_{26}, Xaa_{27} and Xaa_{28} are Ala

Additional examples of exendins that are suitable for use in the compositions disclosed herein are those described by Formula III (SEQ ID No. 5) which is as follows:

Xaa_1 Xaa_2 Xaa_3 Xaa_4 Xaa_5 Xaa_6 Xaa_7 Xaa_8 Xaa_9 Xaa_{10} Xaa_{11} Xaa_{12} Xaa_{13} Xaa_{14} Xaa_{15} Xaa_{16} Xaa_{17} Ala Xaa_{19} Xaa_{20} Xaa_{21} Xaa_{22} Xaa_{23} Xaa_{24} Xaa_{25} Xaa_{26} Xaa_{27} Xaa_{28}-Z_1;

wherein

Xaa_1 is His, Arg, Tyr, Ala, Norval, Val or Norleu;

Xaa_2 is Ser, Gly, Ala or Thr ;

Xaa_3 is Ala, Asp or Glu;

Xaa_4 is Ala, Norval, Val, Norleu or Gly;

Xaa_5 is Ala or Thr ;

Xaa_6 is Ala, Phe, Tyr or naphthylalanine ;

Xaa_7 is Thr or Ser ;

Xaa_8 is Ala, Ser or Thr ;

Xaa_9 is Ala, Norval, Val, Norleu, Asp or Glu ;

Xaa_{10} is Ala, Leu, Ile, Val, pentylglycine or Met ;

Xaa_{11} is Ala or Ser ;

Xaa_{12} is Ala or Lys ;

Xaa_{13} is Ala or Gln;

Xaa_{14} is Ala, Leu, Ile, pentylglycine, Val or Met ;

Xaa_{15} is Ala or Glu ;

Xaa_{16} is Ala or Glu ;

Xaa_{17} is Ala or Glu ;

Xaa_{19} is Ala or Val ;

Xaa_{20} is Ala or Arg ;

Xaa_{21} is Ala or Leu ;

Xaa_{22} is Phe, Tyr or naphthylalanine ;

Xaa_{23} is Ile, Val, Leu, pentylglycine, tert-butylglycine or Met;

Xaa_{24} is Ala, Glu or Asp;

Xaa_{25} is Ala, Trp, Phe, Tyr or naphthylalanine;

Xaa_{26} is Ala or Leu;

Xaa_{27} is Ala or Lys ;

Xaa_{28} is Ala or Asn;

Z_1 is -OH,

$-NH_2$

Gly-Z_2,

Gly Gly-Z_2,

Gly Gly Xaa_{31}-Z_2,

Gly Gly Xaa_{31} Ser-Z_2,

Gly Gly Xaa_{31} Ser Ser-Z_2,

Gly Gly Xaa_{31} Ser Ser Gly-Z_2,

Gly Gly Xaa_{31} Ser Ser Gly Ala-Z_2,

Gly Gly Xaa_{31} Ser Ser Gly Ala Xaa_{36}-Z_2,

Gly Gly Xaa_{31} Ser Ser Gly Ala Xaa_{36} Xaa_{37}-Z_2,

Gly Gly Xaa_{31} Ser Ser Gly Ala Xaa_{36} Xaa_{37} Xaa_{38}-Z_2,

or Gly Gly Xaa_{31} Ser Ser Gly Ala Xaa_{36} Xaa_{37} Xaa_{38} Xaa_{39}-Z_2;

where:

Xaa_{31}, Xaa_{36}, Xaa_{37} and Xaa_{38} are independently Pro, homoproline, 3Hyp, 4Hyp, thioproline, N-alkylglycine, N-alkylpentylglycine or N-alkylalanine;

Xaa_{39} is Ser, Thr or Tyr; and

Z_2 is -OH or-NH_2;

provided that no more than three of Xaa_3, Xaa_4, Xaa_5, Xaa_6, Xaa_8, Xaa_9, Xaa_{10}, Xaa_{11}, Xaa_{12}, Xaa_{13}, Xaa_{14}, Xaa_{15}, Xaa_{16}, Xaa_{17}, Xaa_{19}, Xaa_{20}, Xaa_{21}, Xaa_{24}, Xaa_{25}, Xaa_{26}, Xaa_{27} and Xaa_{28} are Ala;

and provided also that, if Xaa_1 is His, Arg or Tyr, then at least one of Xaa_3, Xaa_4 and Xaa_9 is Ala.

Examples of particular exendins, exendin analogs and exendin derivatives that can be used in the compositions described herein, include, but are not limited to those describe in Table 1. In one embodiment, the bioactive peptide or protein is exendin-4.

Table 1
Exendins, Exendin Analogs and Exendin Derivatives

SEQ ID NO	Sequence
1	His Ser Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser
2	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu .Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser
6	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly
7	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly-NH_2
8	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Ala Ile Glu Phe Leu Lys Asn-NH_2
9	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser-NH_2
10	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
11	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
12	Tyr Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
13	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Tyr NH_2
14	His Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
15	His Gly Glu Gly Thr napthylAla Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2

SEQ ID NO.	Table 1 continued
16	His Gly Glu Gly Thr Phe Ser Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
17	His Gly Glu Gly Thr Phe Ser Thr Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
18	His Gly Glu Gly Thr Phe Thr Thr Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
19	His Gly Glu Gly Thr Phe Thr Ser Glu Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
20	His Gly Glu Gly Thr Phe Thr Ser Asp pentylGly Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH
21	His Gly Glu Gly Thr Phe Thr Ser Asp pentylGly Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
22	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln pentylGly Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
23	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln pentylGly Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
24	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu napthylAla Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
25	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Val Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
26	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Val Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
27	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe tbutylGly Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
28	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe tbutylGly Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2

SEQ ID NO.	Table 1 continued
29	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Asp Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
30	His Ala Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser NH_2
31	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly thioPro Ser Ser Gly Ala thioPro thioPro thioPro Ser NH_2
32	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala thioPro thioPro thioPro Ser NH_2
33	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly homoPro Ser Ser Gly Ala homoPro homoPro homoPro Ser NH_2
34	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala homoPro homoPro homoPro Ser NH_2
35	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly thioPro Ser Ser Gly Ala thioPro thioPro thioPro Ser NH_2
36	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly homoPro Ser Ser Gly Ala homoPro homoPro homoPro Ser NH_2
37	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly NmethylAla Ser Ser Gly Ala NmethylAla NmethylAla NmethylAla Ser NH_2
38	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala NmethylAla NmethylAla NmethylAla Ser NH_2

SEQ ID NO.	Table 1 continued
39	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly NmethylAla Ser Ser Gly Ala NmethylAla NmethylAla NmethylAla Ser NH_2
40	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
41	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
42	His Ala Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
43	His Gly Glu Gly Ala Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
44	His Gly Glu Gly Thr Ala Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
45	His Gly Glu Gly Thr Phe Thr Ala Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
46	His Gly Glu Gly Thr Phe Thr Ser Asp Ala Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
47	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ala Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
48	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Ala Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
49	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Ala Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
50	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Ala Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
51	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Ala Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2

SEQ ID NO.	Table 1 continued
52	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Ala Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
53	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Ala Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
54	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Ala Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
55	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Ala Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
56	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Ala Phe Ile Glu Phe Leu Lys Asn-NH_2
57	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Ala Phe Leu Lys Asn-NH_2
58	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Ala Leu Lys Asn-NH_2
59	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Ala Lys Asn-NH_2
60	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Ala Asn-NH_2
61	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Ala-NH_2
62	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro-NH_2
63	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro-NH_2
64	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro-NH_2

SEQ ID NO.	Table 1 continued
65	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro-NH_2
66	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro-NH_2
67	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro-NH_2
68	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala-NH_2
69	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala-NH_2
70	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly-NH_2
71	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly-NH_2
72	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser-NH_2
73	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser-NH_2
74	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser-NH_2
75	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser-NH_2
76	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro-NH_2
77	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro-NH_2

SEQ ID NO.	Table 1 continued
78	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly-NH_2
79	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly-NH_2
80	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly-NH_2
81	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly thioPro Ser Ser Gly Ala thioPro thioPro thioPro-NH_2
82	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala thioPro thioPro thioPro-NH_2
83	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly NMeala Ser Ser Gly Ala Pro Pro-NH_2
84	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly NMeala Ser Ser Gly Ala NMeAla NmeAla-NH_2
85	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly homoPro Ser Ser Gly Ala homoPro homoPro-NH_2
86	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly homoPro Ser Ser Gly Ala homoPro-NH_2
87	Arg Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala-NH_2
88	His Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly-NH_2
89	His Gly Glu Gly Thr NaphthylAla Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
90	His Gly Glu Gly Thr Phe Ser Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2

SEQ ID NO.	Table 1 continued
91	His Gly Glu Gly Thr Phe Ser Thr Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
92	His Gly Glu Gly Thr Phe Thr Ser Glu Leu Ser Lys Gln Met Ala Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
93	His Gly Glu Gly Thr Phe Thr Ser Asp pentylGly Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
94	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu NaphthylAla Ile Glu Phe Leu Lys Asn-NH_2
95	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe tButylGly Glu Trp Leu Lys Asn-NH_2
96	His Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Asp Phe Leu Lys Asn-NH_2
97	His Gly Glu Gly Thr Phe Thr Ser Asp Ala Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser-NH_2
98	His Gly Glu Gly Thr Phe Thr Ser Asp Ala Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly-NH_2
99	His Gly Glu Gly Thr Phe Thr Ser Asp Ala Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly homoPro Ser Ser Gly Ala homoPro homoPro-NH_2
100	Ala Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
101	His Gly Ala Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
102	His Gly Glu Ala Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
103	His Gly Glu Gly Thr Phe Thr Ser Ala Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2

SEQ ID NO.	Table 1 continued
104	Ala Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
105	His Gly Ala Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
106	His Gly Glu Ala Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
107	His Gly Glu Gly Thr Phe Thr Ser Ala Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
108	His Gly Glu Gly Thr Phe Thr Ser Asp Ala Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
109	Ala Ala Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
110	Ala Ala Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
111	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
112	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
113	Ala Gly Asp Gly Ala Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
114	Ala Gly Asp Gly Ala Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
115	Ala Gly Asp Gly Thr NaphthylAla Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
116	Ala Gly Asp Gly Thr NaphthylAla Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2

SEQ ID NO.	Table 1 continued
117	Ala Gly Asp Gly Thr Phe Ser Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
118	Ala Gly Asp Gly Thr Phe Ser Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
119	Ala Gly Asp Gly Thr Phe Thr Ala Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
120	Ala Gly Asp Gly Thr Phe Thr Ala Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
121	Ala Gly Asp Gly Thr Phe Thr Ser Ala Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
122	Ala Gly Asp Gly Thr Phe Thr Ser Ala Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
123	Ala Gly Asp Gly Thr Phe Thr Ser Glu Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
124	Ala Gly Asp Gly Thr Phe Thr Ser Glu Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
125	Ala Gly Asp Gly Thr Phe Thr Ser Asp Ala Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
126	Ala Gly Asp Gly Thr Phe Thr Ser Asp Ala Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
127	Ala Gly Asp Gly Thr Phe Thr Ser Asp pentylGly Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
128	Ala Gly Asp Gly Thr Phe Thr Ser Asp pentylGly Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
129	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ala Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2

SEQ ID NO.	Table 1 continued
130	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ala Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
131	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Ala Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
132	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Ala Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
133	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Ala Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
134	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Ala Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
135	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Ala Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
136	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Ala Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
137	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln pentylGly Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
138	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln pentylGly Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
139	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Ala Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
140	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Ala Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
141	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Ala Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
142	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Ala Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2

SEQ ID NO.	Table 1 continued
143	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Ala Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
144	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Ala Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
145	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Ala Arg Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
146	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Ala Arg Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
147	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Ala Leu Phe Ile Glu Trp Leu Lys Asn-NH_2
148	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Ala Leu Phe Ile Glu Phe Leu Lys Asn-NH_2
149	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Ala Phe Ile Glu Trp Leu Lys Asn-NH_2
150	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Ala Phe Ile Glu Phe Leu Lys Asn-NH_2
151	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Naphthylala Ile Glu Trp Leu Lys Asn-NH_2
152	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Naphthylala Ile Glu Phe Leu Lys Asn-NH_2
153	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Val Glu Trp Leu Lys Asn-NH_2
154	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Val Glu Phe Leu Lys Asn-NH_2
155	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe tButylgly Glu Trp Leu Lys Asn-NH_2

SEQ ID NO.	Table 1 continued
156	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe tButylgly Glu Phe Leu Lys Asn-NH_2
157	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Asp Trp Leu Lys Asn-NH_2
158	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Asp Phe Leu Lys Asn-NH_2
159	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Ala Leu Lys Asn-NH_2
160	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Ala Leu Lys Asn-NH_2
161	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Ala Lys Asn-NH_2
162	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Ala Lys Asn-NH_2
163	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Ala Asn-NH_2
164	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Ala Asn-NH_2
165	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Ala-NH_2
166	Ala Gly Asp Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Ala-NH_2
167	Ala Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro-NH_2
168	His Gly Ala Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro-NH_2

SEQ ID NO.	Table 1 continued
169	His Gly Glu Ala Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro-NH_2
170	His Gly Glu Gly Thr Phe Thr Ser Ala Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro-NH_2
171	Ala Gly Glu Gly Thr Phe Thr Ser Asp Ala Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro-NH_2
172	Ala Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala-NH_2
173	His Gly Ala Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala-NH_2
174	His Gly Glu Ala Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly-NH_2
175	His Gly Glu Gly Thr Phe Thr Ser Ala Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser-NH_2
176	Ala Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser-NH_2
177	His Gly Ala Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser-NH_2
178	His Gly Glu Ala Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro-NH_2
179	His Gly Glu Gly Thr Phe Thr Ser Ala Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly-NH_2
180	Ala Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly-NH_2
181	His Gly Ala Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly thioPro Ser Ser Gly Ala thioPro thioPro thioPro-NH_2

SEQ ID NO.	Table 1 continued
182	His Gly Glu Ala Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala thioPro thioPro thioPro-NH_2
183	His Gly Glu Gly Thr Phe Thr Ser Ala Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly NMeala Ser Ser Gly Ala NMeala NMeala-NH_2
184	Ala Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly homoPro Ser Ser Gly Ala homoPro-NH_2
185	His Gly Ala Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala-NH_2
186	His Gly Asp Ala Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly-NH_2
187	Ala Gly Glu Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Met Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Trp Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser-NH_2
188	Ala Gly Ala Gly Thr Phe Thr Ser Asp Leu Ser Lys Gln Leu Glu Glu Glu Ala Val Arg Leu Phe Ile Glu Phe Leu Lys Asn Gly Gly Pro Ser Ser Gly Ala Pro Pro Pro Ser-NH_2

In one embodiment, the bioactive peptide or protein of the compositions described herein comprise PYY peptides, PYY peptide analogs and PYY derivatives, such as PYY_{3-36}. Additional PYY peptides that can be used in the compositions disclosed herein include any bioactive PYY peptide, PYY analog or PYY derivative known in the art such as those as described in International Patent Application Publication Nos. WO 02/47712 and WO 03/26591; and US Patent Application Publication No. 2002-141985, all of which are herein incorporated by reference in their entireties and in particular the PYY-related sequences disclosed therein. By "PYY" or "PYY peptide" is meant a Peptide YY polypeptide obtained or derived from any species. Thus, the term "PYY" includes the 36 amino acid full length human as well as species variations of PYY, including, but not limited to, murine, hamster, chicken, bovine, rat and dog PYY. Particular examples of PYY peptides, PYY analogs and PYY derivatives that can be used in the compositions disclosed herein, include, but are not limited to those described in Table 2. Also included are other Y receptor family peptide agonists, particularly Y2, Y5, and putative Y7 receptor agonists and derivatives thereof. In one embodiment, the bioactive peptide is PYY_{3-36}. PYY peptides are known to have activity in food intake, gastric emptying, pancreatic secretion and weight loss.

Table 2

PYY Peptides, Analogs and Derivatives

SEQ ID NO	Sequence
189	Ala Pro Leu Glu Pro Val Tyr Pro Gly Asp Asn Ala Thr Pro Glu Gln Met Ala Gln Tyr Ala Ala Asp Leu Arg Arg Tyr Ile Asn Met Leu Thr Arg Pro Arg Tyr
190	Tyr Pro Ile Lys Pro Glu Ala Pro Gly Glu Asp Ala Ser Pro Glu Glu Leu Asn Arg Tyr Tyr Ala Ser Leu Arg His Tyr Leu Asn Leu Val Thr Arg Gln Arg Tyr
191	Ile Lys Pro Glu Ala Pro Gly Glu Asp Ala Ser Pro Glu Glu Leu Asn Arg Tyr Tyr Ala Ser Leu Arg His Tyr Leu Asn Leu Val Thr Arg Gln Arg Tyr
192	Tyr Pro Ser Lys Pro Asp Asn Pro Gly Glu Asp Ala Pro Ala Glu Asp Met Ala Arg Tyr Tyr Ser Ala Leu Arg His Tyr Ile Asn Leu Ile Thr Arg Gln Arg Tyr
193	Ser Lys Pro Asp Asn Pro Gly Glu Asp Ala Pro Ala Glu Asp Met Ala Arg Tyr Tyr Ser Ala Leu Arg His Tyr Ile Asn Leu Ile Thr Arg Gln Arg Tyr
194	Ala Ser Leu Arg His Tyr Leu Asn Leu Val Thr Arg Gln Arg Tyr

In additional embodiments, the bioactive peptide or protein of the compositions disclosed herein comprise GLP-1, GLP-1 analogs and GLP-1 derivatives such as GLP-1 (7-37), GLP-1(7-36)NH_2, Gly^8 GLP-1(7-37), Ser^{34} GLP-1(7-37) Val^8 GLP-1(7-37) and Val^8 Glu^{22} GLP-1(7-37). Any bioactive GLP-1, GLP-1 analog or GLP-1 derivative known in the art can be used in the present compositions, including, but not limited to those described in International Patent Application Publications Nos. WO 01/98331, WO 02/48192; US Patent Application Nos. 2003-220243 and 2004-053819; and US Patent Nos. 5,981,488, 5,574,008, 5,512,549, and 5,705,483, all of which are herein incorporated by reference in their entireties and in particular the GLP-1-related sequences described therein. Examples of GLP-1 peptides that are suitable for use in the compositions disclosed herein are those described in US Patent Application 2003-220243 by the following formulas:

Formula IV (SEQ ID No. 244)

His-Xaa_8-Glu-Gly-Xaa_{11}-Xaa_{12}-Thr-Ser-Asp-Xaa_{16}-Ser-Ser-Tyr-Leu-Glu-Xaa_{22}-Xaa_{23}-Xaa_{24}-Ala-Xaa_{26}-Xaa_{27}-Phe-Ile-Ala-Xaa_{31}-Leu-Xaa_{33}-Xaa_{34}-Xaa_{35}-Xaa_{36}-R

where:

Xaa_8 is Gly, Ala, Val, Leu, Ile, Ser, or Thr;

Xaa_{11} is Asp, Glu, Arg, Thr, Ala, Lys, or His;

Xaa_{12} is His, Trp, Phe, or Tyr;

$Xaa_{16}$is Leu, Ser, Thr, Trp, His, Phe, Asp, Val, Glu, or Ala;

Xaa_{22} is Gly, Asp, Glu, Gln, Asn, Lys, Arg, Cys, or Cysteic Acid;

Xaa_{23} is His, Asp, Lys, Glu, or Gln;

Xaa_{24} is Glu, His, Ala, or Lys;

Xaa_{26} is Asp, Lys, Glu, or His;

$Xaa_{27}$is Ala, Glu, His, Phe, Tyr, Trp, Arg, or Lys;

Xaa_{31} is Ala, Glu, Asp, Ser, or His;

Xaa_{33} is Asp, Arg, Val, Lys, Ala, Gly, or Glu;

Xaa_{34} is Glu, Lys, or Asp;

Xaa_{35} is Thr, Ser, Lys, Arg, Trp, Tyr, Phe, Asp, Gly, Pro, His, or Glu;

Xaa_{36} is Arg, Glu, or His; and

R is: Lys, Arg, Thr, Ser, Glu, Asp, Trp, Tyr, Phe, His, --NH_2, Gly, Gly-Pro, or Gly-Pro-NH_2, or is deleted.

Formula V (SEQ ID No. 245)

His-Xaa_8-Glu-Gly-Thr-Xaa_{12}-Thr-Ser-Asp-Xaa_{16}-Ser-Ser-Tyr-Leu-Glu-Xaa_{22}-Xaa_{23}-Ala-Ala-Xaa_{26}-Glu-Phe-Ile-Xaa_{30}-Trp-Leu-Val-Lys-Xaa_{35}-Arg-R

where:

Xaa_8 is Gly, Ala, Val, Leu, Ile, Ser, or Thr;

Xaa_{12} is His, Trp, Phe, or Tyr;

Xaa_{16} is Leu, Ser, Thr, Trp, His, Phe, Asp, Val, Glu, or Ala;

Xaa_{22} is Gly, Asp, Glu, Gln, Asn, Lys, Arg, Cys, or Cysteic Acid (3-Sulfoalanine);

Xaa_{23} is His, Asp, Lys, Glu, or Gln;

Xaa_{26} is: Asp, Lys, Glu, or His;

Xaa_{30} is Ala, Glu, Asp, Ser, or His;

Xaa_{35} is Thr, Ser, Lys, Arg, Trp, Tyr, Phe, Asp, Gly, Pro, His, or Glu; and

R is: Lys, Arg, Thr, Ser, Glu, Asp, Trp, Tyr, Phe, His, --NH_2, Gly, Gly-Pro, or Gly-Pro-NH_2, or is deleted.

Formula VI (SEQ ID No. 246)

His-Xaa_8-Glu-Gly-Thr-Phe-Thr-Ser-Asp-Val-Ser-Ser-Tyr-Leu-Glu-Xaa_{22}-Xaa_{23}-Ala-Ala-Lys-Xaa_{27}-Phe-Ile-Xaa_{30}-Trp-Leu-Val-Lys-Gly-Arg-R

where:

Xaa_8 is Gly, Ala, Val, Leu, Ile, Ser, or Thr;

Xaa_{22} is Gly, Asp, Glu, Gln, Asn, Lys, Arg, Cys, or Cysteic Acid (3-Sulfoalanine);

Xaa_{23} is His, Asp, Lys, Glu, or Gln;

Xaa_{27} is Ala, Glu, His, Phe, Tyr, Trp, Arg, or Lys

Xaa_{30} is Ala, Glu, Asp, Ser, or His; and

R is: Lys, Arg, Thr, Ser, Glu, Asp, Trp, Tyr, Phe, His, --NH_2, Gly, Gly-Pro, or Gly-Pro-NH_2, or is deleted.

Formula VII (SEQ ID No. 247)

Xaa_7-Xaa_8-Glu-Gly-Thr-Phe-Thr-Ser-Asp-Val-Ser-Ser-Tyr-Leu-Glu-Xaa_{22}-Gln-Ala-Ala-Lys-Glu-Phe-Ile-Ala-Trp-Leu-Val-Lys-Gly-Arg-R

where:

Xaa_7 is L-histidine, D-histidine, desamino-histidine, 2amino-histidine, β-hydroxy-histidine, homohistidine, α-fluoromethyl-histidine or α-methyl-histidine;

Xaa_8 is glycine, alanine, valine, leucine, isoleucine, serine or threonine;

Xaa_{22} is aspartic acid, glutamic acid, glutamine, asparagine, lysine, arginine, cysteine, or cysteic acid; and

R is --NH_2 or Gly(OH).

Particular, but non-limiting examples of GLP1 peptides that can be use in the present compositions can be found in Table 3

Table 3
GLP-1 Peptides, Analogs and Derivatives

SEQ ID NO	Sequence
195	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
196	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Asp Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
197	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Arg Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
198	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Lys Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
199	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
200	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Asp Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
201	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Arg Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
202	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Lys Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
203	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Glu Trp Leu Val Lys Gly Arg Gly
204	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Glu Trp Leu Val Lys Gly Arg Gly
205	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg His
206	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg His

SEQ ID No	Table 3 continued
207	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Gln Ala Ala Lys Ala Phe Ile Ala Trp Leu Val Lys Gly Arg His
208	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Lys Glu Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg His
209	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
210	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
211	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Asp Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
212	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Arg Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
213	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Lys Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
214	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu 3-sulfoAla Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
215	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu 3-sulfoAla Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
216	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu 3-sulfoAla Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
217	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
218	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Asp Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
219	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Arg Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg

SEQ ID NO.	Table 3 continued
220	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Lys Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
221	His Ala Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu 3-sulfoAla Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
222	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
223	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Asp Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
224	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Arg Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
225	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Lys Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
226	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu 3-sulfoAla Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
227	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
228	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Asp Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
229	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Arg Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
230	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Lys Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
231	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu 3-sulfoAla Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg
232	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Lys Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly

SEQ ID NO.	Table 3 continued
233	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Ala Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
234	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Glu Trp Leu Val Lys Gly Arg Gly
235	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Glu Trp Leu Val Lys Gly Arg Gly
236	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys His Arg Gly
237	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg His
238	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Lys Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
239	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Glu Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
240	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Glu Gln Ala Ala Lys Ala Phe Ile Ala Trp Leu Val Lys Gly Arg Gly
241	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Gly Lys Arg Gly
242	His Val Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg His
243	His Gly Glu Gly Thr Phe Thr Ser Asp Val Ser Ser Tyr Leu Glu Gly Gln Ala Ala Lys Glu Phe Ile Ala Trp Leu Val Lys Gly Arg His

In further embodiments, the bioactive peptide or pritein of the compositions disclosed herein comprise amylin, amylin analogs and amylin derivatives. Any amylin, amylin analogs or amylin deriviatives known in the art can be used in the present compositions, including, but not limited to those disclosed in US Patent Nos. 6,610,824, 5,686,411, 5,580,953, 5,367,052 and 5,124,314, all of which are incorporated herein by reference in their entireties and in particular the amylin-related sequences described therein. Examples of amylin peptides that may be used are described by the following formula:

Formula VIII (SEQ ID NO. 248)

A_1 -X-Asn-Thr-Ala-Thr-Y-Ala-Thr-Gln-Arg-Leu-B_1-Asn-Phe-Leu-C_1-D_1-E_1-F_1-G_1-Asn-H_1-Gly-I_1-J_1-Leu-K_1-L_1-Thr-M_1-Val-Gly-Ser-Asn-Thr-Tyr-Z, where:

A_1 is Lys, Ala, Ser or hydrogen,

B_1 is Ala, Set or Thr;

C_1 is Val, Leu or Ile;

D_1 is His or Arg;

E_1 is Ser or Thr;

F_1 is Ser, Thr, Gln or Asn;

G_1 is Asn, Gln or His;

H_1 is Phe, Leu or Tyr;

I_1 is Ala or Pro;

J_1 is Ile, Val, Ala or Leu;

K_1 is Ser, Pro, Leu, Ile or Thr;

L_1 is Ser, Pro or Thr;

M_1 is Asn, Asp, or Gln;

X and Y are independently selected amino acid residues having side chains which are chemically bonded to each other to form an intramolecular linkage; and

Z is amino, alkylamino, dialkylamino, cycloalkylamino, arylamino, aralkylamino, alkyloxy, aryloxy or aralkyloxy. Particular, but non-limiting examples of amylin analogs and derivatives that can be used are presented in Table 4.

Table 4

SEQ ID NO	Sequence
249	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Ala Ile Leu Ser Ser Thr Asn Val Gly Ser Asn Thr Tyr
250	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Ile Arg Ser Ser Asn Asn Leu Gly Ala Ile Leu Ser Pro Thr Asn Val Gly Ser Asn Thr Tyr
251	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val Arg Thr Ser Asn Asn Leu Gly Ala Ile Leu Ser Pro Thr Asn Val Gly Ser Asn Thr Tyr
252	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val Arg Ser Ser Asn Asn Leu Gly Pro Val Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
253	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Asn Asn Asn Leu Gly Pro Val Leu Ser Pro Thr Asn Val Gly Ser Asn Thr Tyr
254	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Thr Asn Phe Leu Val Arg Ser Ser His Asn Leu Gly Ala Ala Leu Leu Pro Thr Asp Val Gly Ser Asn Thr Tyr
255	Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Ala Ile Leu Ser Ser Thr Asn Val Gly Ser Asn Thr Tyr
256	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Ala Ile Leu Pro Ser Thr Asn Val Gly Ser Asn Thr Tyr
257	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Pro Ile Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
258	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val Arg Ser Ser Asn Asn Phe Gly Pro Ile Leu Pro Ser Thr Asn Val Gly Ser Asn Thr Tyr
259	Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Arg Ser Asn Asn Phe Gly Pro Ile Leu Pro Ser Thr Asn Val Gly Ser Asn Thr Tyr
260	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Pro Val Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr

SEQ ID NO	Table 4 continued
261	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val Arg Ser Ser Asn Asn Phe Gly Pro Ile Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
262	Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val Arg Ser Ser Asn Asn Phe Gly Pro Ile Leu Pro Pro Ser Asn Val Gly Ser Asn Thr Tyr
263	Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Pro Ile Leu Pro Pro Ser Asn Val Gly Ser Asn Thr Tyr
264	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Leu Gly Pro Val Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
265	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Leu Gly Pro Val Leu Pro Ser Thr Asn Val Gly Ser Asn Thr Tyr
266	Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Leu Gly Pro Val Leu Pro Ser Thr Asn Val Gly Ser Asn Thr Tyr
267	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val Arg Ser Ser Asn Asn Leu Gly Pro Val Leu Pro Ser Thr Asn Val Gly Ser Asn Thr Tyr
268	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val Arg Ser Ser Asn Asn Leu Gly Pro Ile Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
269	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val Arg Ser Ser Asn Asn Leu Gly Pro Ile Leu Pro Ser Thr Asn Val Gly Ser Asn Thr Tyr
270	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Ile His Ser Ser Asn Asn Leu Gly Pro Ile Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
271	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val Ile Ser Ser Asn Asn Phe Gly Pro Ile Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
272	Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Ile His Ser Ser Asn Asn Leu Gly Pro Ile Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
273	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Ile Arg Ser Ser Asn Asn Leu Gly Ala Ile Leu Ser Ser Thr Asn Val Gly Ser Asn Thr Tyr

SEQ ID NO	Table 4 continued
274	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Ile Arg Ser Ser Asn Asn Leu Gly Ala Val Leu Ser Pro Thr Asn ValGly Ser Asn Thr Tyr
275	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Ile Arg Ser Ser Asn Asn Leu Gly Pro Val Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
276	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Thr Asn Phe Leu Val His Ser Ser His Asn Leu Gly Ala Ala Leu Leu Pro Thr Asp Val Gly Ser Asn Thr Tyr
277	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Thr Asn Phe Leu Val His Ser Ser His Asn Leu Gly Ala Ala Leu Ser Pro Thr Asp Val Gly Ser Asn Thr Tyr
278	Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Thr Asn Phe Leu Val His Ser Ser His Asn Leu Gly Ala Val Leu Pro Ser Thr Asp Val Gly Ser Asn Thr Tyr
279	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Thr Asn Phe Leu Val Arg Ser Ser His Asn Leu Gly Ala Ala Leu Ser Pro Thr Asp Val Gly Ser Asn Thr Tyr
280	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Thr Asn Phe Leu Val Arg Ser Ser His Asn Leu Gly Ala Ile Leu Pro Pro Thr Asp Val Gly Ser Asn Thr Tyr
281	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Thr Asn Phe Leu Val Arg Ser Ser His Asn Leu Gly Pro Ala Leu Pro Pro Thr Asp Val Gly Ser Asn Thr Tyr
282	Lys Asp Asn Thr Ala Thr Lys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Ala Ile Leu Ser Ser Thr Asn Val Gly Ser Asn Thr Tyr
283	Ala Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Ala Ile Leu Ser Ser Thr Asn Val Gly Ser Asn Thr Tyr
284	Ser Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Ala Ile Leu Ser Ser Thr Asn Val Gly Ser Asn Thr Tyr
285	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Ala Ile Leu Ser Pro Thr Asn Val Gly Ser Asn Thr Tyr
286	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Pro Ile Leu Pro Ser Thr Asn Val Gly Ser Asn Thr Tyr

SEQ ID NO	Table 4 continued
287	Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Pro Ile Leu Pro Ser Thr Asn Val Gly Ser Asn Thr Tyr
288	Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Pro Val Leu Pro Pro Ser Asn Val Gly Ser Asn Thr Tyr
289	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Ala Ile Leu Ser Ser Thr Asn Val Gly Ser Asn Thr Tyr
290	Lys Cys Asn Thr Ala Thr Cys Ala Thr Gln Arg Leu Ala Asn Phe Leu Val His Ser Ser Asn Asn Phe Gly Pro Ile Leu Pro Pro Thr Asn Val Gly Ser Asn Thr Tyr
291	Lys Cys Asn Thr Ala Thr Cys Val Leu Gly Arg Leu Ser Gln Glu Leu His Arg Leu Gln Thr Tyr Pro Arg Thr Asn Thr Gly Ser Asn Thr Tyr NH_2
292	Cys Ser Asn Leu Ser Thr Cys Val Leu Gly Arg Leu Ser Gln Glu Leu His Arg Leu Gln Thr Tyr Pro Arg Thr Asn Thr Gly Ser Ans Thr Tyr NH_2

Included in the compositions and methods disclosed herein are analogs and derivatives of bioactive peptides or proteins that have undergone one or more amino acid substitutions, additions or deletions. In one embodiment, the analog or derivative has undergone not more than 10 amino acid substitutions, deletions and/or additions. In another embodiment, the analog or derivative has undergone not more than 5 amino acid substitutions, deletions and/or additions.

Substitutions of amino acids within a peptide or protein while retaining at least one of the biological activities associated with the parent peptide or protein is known within the art of protein chemistry. It is recognized in the art that modifications in the amino acid sequence of a peptide, polypeptide, or protein can result in equivalent, or possibly improved, second generation peptides, etc., that display equivalent or superior functional characteristics when compared to the original amino acid sequence. Alterations can include amino acid insertions, deletions, substitutions, truncations, fusions, shuffling of subunit sequences, and the like.

One factor that can be considered in making such changes is the hydropathic index of amino acids. The importance of the hydropathic amino acid index in conferring interactive biological function on a protein has been discussed by Kyte and Doolittle (*J. Mol. Biol.*, 157: 105-132, 1982). It is accepted that the relative hydropathic character of amino acids contributes to the secondary structure of the resultant protein.

Based on its hydrophobicity and charge characteristics, each amino acid has been assigned a hydropathic index as follows: isoleucine (+4.5); valine (+4.2); leucine (+3.8); phenylalanine (+2.8); cysteine/cystine (+2.5); methionine (+1.9); alanine (+1.8); glycine (-0.4); threonine (-0.7); serine (-0.8); tryptophan (-0.9); tyrosine (-1.3); proline (-1.6); histidine (-3.2); glutamate/glutamine/aspartate/asparagine (-3.5); lysine (-3.9); and arginine (-4.5).

As is known in the art, certain amino acids in a peptide or protein can be substituted for other amino acids having a similar hydropathic index or score and produce a resultant peptide or protein having similar biological activity, i.e., which still retains biological functionality. In making such changes, it is preferable that amino acids having hydropathic indices within ± 2 are substituted for one another. More preferred substitutions are those wherein the amino acids have hydropathic

indices within ±1. Most preferred substitutions are those wherein the amino acids have hydropathic indices within ±0.5.

Like amino acids can also be substituted on the basis of hydrophilicity. U.S. Patent No. 4,554,101 discloses that the greatest local average hydrophilicity of a protein, as governed by the hydrophilicity of its adjacent amino acids, correlates with a biological property of the protein. The following hydrophilicity values have been assigned to amino acids: arginine/lysine (+3.0); aspartate/glutamate (+3.0 ±1); serine (+0.3); asparagine/glutamine (+0.2); glycine (0); threonine (-0.4); proline (-0.5 ±1); alanine/histidine (-0.5); cysteine (-1.0); methionine (-1.3); valine (-1.5); leucine/isoleucine (-1.8); tyrosine (-2.3); phenylalanine (-2.5); and tryptophan (-3.4). Thus, one amino acid in a peptide, polypeptide, or protein can be substituted by another amino acid having a similar hydrophilicity score and still produce a resultant protein having similar biological activity, i.e., still retaining correct biological function. In making such changes, amino acids having hydrophilicity values within ±2 are preferably substituted for one another, those within ±1 are more preferred, and those within ±0.5 are most preferred.

As outlined above, amino acid substitutions in the bioactive peptides and proteins for use in the compositions and methods disclosed herein can be based on the relative similarity of the amino acid side-chain substituents, for example, their hydrophobicity, hydrophilicity, charge, size, etc. Exemplary substitutions that take various of the foregoing characteristics into consideration in order to produce conservative amino acid changes resulting in silent changes can be selected from other members of the class to which the naturally occurring amino acid belongs. Amino acids can be divided into the following four groups: (1) acidic amino acids; (2) basic amino acids; (3) neutral polar amino acids; and (4) neutral non-polar amino acids. Representative amino acids within these various groups include, but are not limited to: (1) acidic (negatively charged) amino acids such as aspartic acid and glutamic acid; (2) basic (positively charged) amino acids such as arginine, histidine, and lysine; (3) neutral polar amino acids such as glycine, serine, threonine, cysteine, cystine, tyrosine, asparagine, and glutamine; and (4) neutral non-polar amino acids such as alanine, leucine, isoleucine, valine, proline, phenylalanine, tryptophan, and methionine. It should be noted that changes which are not expected to be advantageous can also be useful if these result in the production of functional sequences.

Also included within the scope of the bioactive peptides and proteins that can be used in the present compositions are conjugates of the above referenced proteins, peptides and peptide analogs, *e.g.*, chemically modified with or linked to at least one molecular weight enhancing compound known in the art such as polyethylene glycol, and chemically modified equivalents of such proteins, peptides, analogs, or conjugates. The polyethylene glycol polymers may have molecular weights between about 500 Da and 20,000 Da. Preferred conjugates include those described in International Patent Publication No. WO 00/66629, which is herein incorporated by reference in its entirety. In one embodiment, the bioactive peptides and proteins of the invention have a molecular weight up to about 100,000 Da, in another embodiment up to about 25,000 Da, while in still another embodiment up to about 5,000 Da.

As used herein, the terms "protein" or "peptide" include any molecule that comprises five or more amino acids. It is well known in the art that proteins may undergo modification, including post-translational modifications, such as, but not limited to, disulfide bond formation, glycosylation, phosphorylation, or oligomerization. Thus, as used herein, the term "protein" or "peptide" includes any protein or peptide that is modified by any biological or non-biological process.

The term "amino acid" is used in its broadest sense, and includes naturally occurring amino acids as well as non-naturally occurring amino acids, including amino acid analogs and derivatives. The latter includes molecules containing an amino acid moiety. One skilled in the art will recognize, in view of this broad definition, that reference herein to an amino acid includes, for example, naturally occurring proteogenic L-amino acids; D-amino acids; chemically modified amino acids such as amino acid analogs and derivatives; naturally occurring non-proteogenic amino acids such as norleucine, β-alanine, ornithine, norvaline, homocysteine, homoserine etc.; and chemically synthesized compounds having properties known in the art to be characteristic of amino acids. As used herein, the term "proteogenic" indicates that the amino acid can be incorporated into a peptide, polypeptide, or protein in a cell through a metabolic pathway.

The term "polyamino acid" refers to any homopolymer or mixture of homopolymers of a particular amino acid.

As used herein in reference to a peptide or protein, the term "derivative" means a protein or peptide that is obtained by modification of a parent protein or peptide, for example, by amino acid substitution, addition or deletion. In one embodiment, derivatives have at least 15% sequence identity to the parent molecule. In other embodiments, derivatives have at least 50%, at least 70%, at least 80%, at least 90% or at least 95% sequence identity with the parental protein or peptide.

As used herein "analog" refers to bioactive peptides or proteins that are structurally related to a parent peptide or protein by amino acid sequence but which differ from the parent in a characteristic of interest such as bioactivity, solubility, resistance to proteolysis, etc. In certain embodiments, analogs have activities between about 1% to about 10,000%, about 10% to about 1000%, and about 50% to about 500% of the bioactivity of the parental protein or peptide.

The term "bioactive" or "bioactivity" means the ability to affect any physical or biochemical properties of a biological organism, including but not limited to viruses, bacteria, fungi, plants, animals, and humans. In particular, as used herein, bioactive includes diagnosis, cure, mitigation, treatment, or prevention of disease in humans or other animals, or to otherwise enhance physical or mental well-being of humans or animals.

As used herein "subject" or "patient" refers to any animal including domestic animals such as domestic livestock and companion animals. The terms are also meant to include human beings.

The cationic polyamino acids of the invention include polymers of basic amino acids, such as histidine, arginine, and lysine, that are protonated in a neutral or acidic pH environment and are thus cationic. The molecular weight of such polymers, *e.g.*, poly-L-histidine, poly-L-arginine, poly-L-lysine, or copolymers thereof, are generally between about 10 and about 200 kDa. In another embodiment, the polymers have an average molecular weight of between about 100kDa and about 200kDa. In still a further embodiment, the polymers have an average molecular weight between about 140kDa and about 150kDa, while in yet another embodiment the polymers have an average molecular weight of between about 140 kDa and about 200 kDa. In one particular embodiment the cationic polyamino acid of the composition is poly-L-arginine hydrochloride with an average molecular weight of about 141 kDa.

Buffers useful in connection with the compositions and methods disclosed herein can be any buffer that displays adequate buffering capacity (buffer value) at the pH ranges which render the bioactive peptides and proteins of the invention chemically stable for the duration of use, and which are physically compatible with the cationic polyamino acids of the invention at the concentrations and pHs of use, *i.e.*, they do not cause precipitation of the cationic polyamino acid. Methods for calculating the buffering capacity (buffer value) of a buffer at a particular concentration and pH are well known in the art and can be determined by the skilled artisan without undue experimentation.

It has been found that traditional buffer components with multi-anionic charges such as citric acid generally are not physically compatible with the cationic polyamino acids of the invention, resulting in precipitation of the polyamino acid. However, buffer components containing neutral and mono-anionic net charges are compatible with, and can be used in combination with the cationic polyamino acids of the invention. Examples of suitable buffers include, but are not limited to acetic acid, ε-aminocaproic acid, and glutamic acid.

The pharmaceutical compositions of the invention may further comprise any number of known pharmaceutically acceptable excipients such as, but not limited to, tonicifying agents, viscosity-increasing agents, bioadhesive agents, preservatives, diluents, carriers, and the like.

Examples of tonicifying agents that may be used, include, but are not limited to, sodium chloride, mannitol, sucrose, and glucose. However, any tonicifying agent known in the art to prevent mucosal irritation can be used.

Exemplary viscosity-increasing and bioadhesive agents that may be used in the compositions disclosed herein, include, but are not limited to, cellulose derivatives (*e.g.*, hydroxypropyl cellulose, hydroxypropyl methylcellulose or methylcellulose of average molecular weight between 10 and 1,500 kDa), starch, gums, carbomers, and polycarbophil. However, any viscosity-increasing or bioadhesive agents known in the art to afford a higher viscosity or to increase the residence time of the pharmaceutical composition at the absorption site may be used.

With the availability of preservative-free spray systems to the pharmaceutical industry, the incorporation of preservative(s) becomes optional in the composition of this invention. Should a preservative system be required or desired, preservative(s) may be added such as phenylethyl alcohol, methylparaben, ethylparaben,

propylparaben, butylparaben, chlorbutanol, benzoic acid, sorbic acid, phenol, m-cresol and alcohol.

The compositions of the present invention can further comprise aqueous carriers, non-aqueous carriers or suspension media. For instance, the pharmaceutical compositions of the invention may be formulated as an aqueous solution in purified water, or may be dispersed in non-aqueous media to thereby be compatible with aerosolization or delivery by instillation in non-aqueous suspension media. By way of example, such non-aqueous suspension media can include hydrofluoroalkanes, fluorocarbons, perfluorocarbons, fluorocarbon/hydrocarbon diblocks, hydrocarbons, alcohols, ethers, and combinations thereof. However, it is understood that any non-aqueous suspension media known in the art may be used in conjunction with the compositions and method disclosed herein.

As mentioned above, the pharmaceutical compositions of the invention may be formulated in a variety of dosage forms suitable for transmucosal delivery, as known in the art. For instance, the compositions may be formulated as an aqueous solution or suspension, a non-aqueous solution or suspension, a tablet, or a dry powder. In any event, the compositions of the invention will generally comprise a therapeutically or prophylactically effective amount of a bioactive peptide or protein and an absorption enhancing amount of a mixture comprising a cationic polyamino acid and a buffer that is compatible with the cationic polyamino acid.

One embodiment provides a pharmaceutical composition for nasal delivery in the form of an aqueous solution with enhanced transmucosal absorption, wherein the pharmaceutical composition includes a bioactive peptide or protein; an absorption enhancing cationic polyamino acid; a buffer that is compatible with said cationic polyamino acid; and a bioadhesive agent. Another embodiment of the invention provides a pharmaceutical composition for sublingual delivery in the form of a tablet.

In one embodiment, the weight ratio of bioactive peptide or protein to cationic polyamino acid in the final formulation ranges from 1:100 to 100:1, in another embodiment from 1:25 to 25:1, in yet another embodiment from 1:10 to 10:1, and in still yet another embodiment from 1:2 to 2:1.

The weight ratio of cationic polyamino acid to buffer can vary widely and may be determined by routine experimentation. The only limitation is that adequate buffer is included such that the cationic polyamino acid does not precipitate in the formulated dosage form or upon administration to the desired mucous membrane. In

one embodiment the useful weight ratios of cationic polyamino acid to buffer range from 1:100 to 100:1, while in another embodiment the weight ratio of cationic polyamino acid to buffer ranges from 1:25 to 25:1. In other embodiments, the weight ratio of cationic polyamino acid to buffer ranges from 1:10 to 10:1, and from 1:2 to 2:1

When formulated as an aqueous solution, the instant pharmaceutical compositions may comprise: 0.01%-5.0% (w/v) of the bioactive peptide or protein; 0.01%-1.0% (w/v) of the cationic polyamino acid; 0.01%-10.0% (w/v) of the buffer; 0.001%-10.0% (w/v) of the optional tonicifying agent; 0.001%-10.0% (w/v) of the optional viscosity-increasing agent; 0.001%-10.0% (w/v) of the optional bioadhesive agent; 0.001%-10.0% (w/v) of the optional preservative; q.s. (*quantum sufficiat*) to 100.0% (w/v) of purified water;

The term "therapeutically or prophylactically effective amount" as used herein refers to an amount of a bioactive peptide or protein to treat, ameliorate, or prevent a disease or condition of interest, or to exhibit a detectable therapeutic or preventative effect. The effect can be detected by, for example, a reduction of plasma glucose or HbA_{1c} levels, or reduction or maintenance of body weight. Therapeutic effects also include reduction in physical symptoms. The precise effective amount for a subject will depend upon the subject's size and health, the nature and extent of the condition, and the therapeutics or combination of therapeutics selected for administration. Generally, the effective amount for a given situation can be determined by routine experimentation and is within the judgement of the clinician.

The exact dosage will be determined by the practitioner, in light of factors related to the subject that requires treatment. Dosage and administration are adjusted to provide sufficient levels of the active moiety or to maintain the desired effect. Factors that may be taken into account include the severity of the disease state, general health of the subject, age, weight, and gender of the subject, diet, time and frequency of administration, drug combination(s), reaction sensitivities, and tolerance/response to therapy. Long-acting pharmaceutical compositions may be administered every 3 to 4 days, every week, or once every two weeks depending on half-life and clearance rate of the active ingredient in the particular formulation.

For any compound, the therapeutically effective dose can be estimated initially either in cell culture assays, *e.g.*, of neoplastic cells, or in animal models, usually mice, rats, rabbits, dogs, or pigs. The animal model may also be used to determine

the appropriate concentration range and route of administration. Such information can then be used to determine useful doses and routes for administration in humans. Further, therapeutic efficacy and toxicity may be determined by standard pharmaceutical procedures in cell cultures or experimental animals, *e.g.*, ED_{50} (the dose therapeutically effective in 50% of the population) and LD_{50} (the dose lethal to 50% of the population). The dose ratio between therapeutic and toxic effects is the therapeutic index, and it can be expressed as the ratio, ED_{50}/LD_{50}. Pharmaceutical compositions which exhibit large therapeutic indices are preferred. The data obtained from cell culture assays and animal studies is used in formulating a range of dosage for human use. The dosage contained in such compositions is preferably within a range of circulating concentrations that include the ED_{50} with little or no toxicity. The dosage varies within this range depending upon the dosage form employed, sensitivity of the patient, and the route of administration.

The term "absorption enhancing amount" as used herein refers to an amount of the absorption enhancing mixture such that the transmucosal absorption of the bioactive peptide or protein is enhanced by at least 2-fold, at least 5-fold, or at least 10-fold, as compared to transmucosal absorption of the bioactive peptide or protein in the absence or substantial absence of the absorption enhancing mixture. Generally, an effective absorption enhancing amount for a given situation can be determined by routine experimentation.

In one embodiment, the pharmaceutical composition is formulated as an aqueous solution and includes: exendin-4; poly-L-arginine of average molecular weight between 10 and 200 kDa; glutamate buffer at pH between 4.0 and 5.0; sodium chloride; and purified water. In another embodiment, the pharmaceutical composition includes: exendin-4; poly-L-arginine of average molecular weight between 10 and 200 kDa; glutamate buffer at pH between 4.0 and 5.0; sodium chloride; hydroxypropyl methylcellulose of average molecular weight between 10 kDa and 1,500 kDa; and purified water.

In a further embodiment, the pharmaceutical composition may include exendin-4 at a concentration between 0.01% and 5.0% (w/v); poly-L-arginine of average molecular weight between 10 kDa and 200 kDa at a concentration between 0.01% and 1.0% (w/v); glutamate buffer at pH between 4.0 and 5.0 at a concentration between 0.01% and 10.0% (w/v); sodium chloride at a concentration between 0.001% and 0.9% (w/v); and purified water to 100%.

In another embodiment, the pharmaceutical composition includes exendin-4 at a concentration between 0.01% and 5.0% (w/v); poly-L-arginine of average molecular weight between 10 kDa and 200 kDa at a concentration between 0.01% and 1.0% (w/v); glutamate buffer at pH between 4.0 and 5.0 at a concentration between 0.01% and 10.0% (w/v); sodium chloride at a concentration between 0.001% and 0.9% (w/v); hydroxypropyl methylcellulose of average molecular weight 10 kDa and 1,500 kDa at a concentration between 0.001% and 10.0% (w/v); and purified water to make 100%.

In yet another embodiment of the invention, the pharmaceutical composition includes exendin-4 at a concentration of 0.5% to 1.0% (w/v); poly-L-arginine hydrochloride of average molecular weight 141 kDa at a concentration of 0.5% (w/v); glutamate buffer at pH 4.5 at a concentration of 0.56% (w/v); sodium chloride at a concentration of 0.72% (w/v); and purified water to 100%.

In another embodiment, the pharmaceutical composition of the invention may include exendin-4 at a concentration of 0.5% to 1.0% (w/v); poly-L-arginine hydrochloride of average molecular weight of 141 kDa at a concentration of 0.5% (w/v); glutamate buffer at pH of 4.5 at a concentration of 0.56% (w/v); sodium chloride at a concentration of 0.72% (w/v); hydroxypropyl methylcellulose of average molecular weight ranging from about 4 to about 86 kDa at a concentration 0.5% (w/v); and purified water to 100%.

In one aspect of the invention, the compositions disclosed herein can be formulated for transmucosal delivery to or via the mucous membranes of a patient in need of treatment. Such formulations can be delivered to or via the mucous membranes for prophylactic or therapeutic purposes in any manner known in the art such as, but not limited to, drops, sprays, tablets, dry-powder inhalation, instillation, metered dose inhalation, nebulization, aerosolization, or instillation as suspension in compatible vehicles. More particularly, ocular, nasal, pulmonary, buccal, sublingual, rectal, or vaginal administration is contemplated as within the scope of the invention.

In one embodiment, the pharmaceutical composition may be administered as an aqueous solution in the form of drops or a spray. In another embodiment, the pharmaceutical composition disclosed herein may be administered as a dry powder formulation. In yet another embodiment, the pharmaceutical composition may be administered as a tablet formulation, wherein the tablet preferably comprises a bioadhesive agent.

The compositions disclosed herein may also be administered via aerosolization, such as with a dry powder inhaler (DPI), metered dose inhaler (MDI), liquid dose instillation (LDI), and nebulizers. DPIs, MDIs, LDIs, and nebulizers are all well known in the art and could easily be employed for administration of the pharmaceutical compositions of the invention without undue experimentation.

In another aspect, a method for enhancing the transmucosal absorption of a bioactive peptide or protein is provided, wherein the method involves administering the bioactive peptide or protein to a subject via a mucous membrane in conjunction with an absorption enhancing composition comprising a cationic polyamino acid and a buffer that is compatible with that cationic polyamino acid.

Generally stated, the transmucosal absorption of the bioactive peptide or protein is enhanced relative to the transmucosal absorption of the bioactive peptide or protein in the absence or substantial absence of the absorption enhancing composition comprising a cationic polyamino acid. In one embodiment, the transmucosal absorption of the bioactive peptide or protein is improved by at least 2-fold, in another embodiment at least 5-fold, and in still another embodiment by at least 10-fold over the transmucosal absorption of the bioactive peptide or protein when administered to a subject via transmucosal delivery in the absence or the substantial absence of the absorption enhancing composition.

In one embodiment, the bioactive peptide or protein is administered as an aqueous solution comprising the absorption enhancing composition. In another embodiment, the bioactive peptide or protein is administered as a dry powder formulation comprising the absorption enhancing composition. In yet another embodiment, the bioactive peptide or protein is administered as a tablet formulation comprising the absorption enhancing composition, wherein the absorption enhancing composition optionally further comprises a bioadhesive agent.

Another aspect relates to a method for improving the bioavailability of a bioactive peptide or protein administered to a subject via transmucosal delivery, wherein the method generally involves administering the bioactive peptide or protein to a subject via a mucous membrane in conjunction with an absorption enhancing composition comprising a cationic polyamino acid and a buffer that is compatible with that cationic polyamino acid. According to one embodiment of the method, the bioavailability of the bioactive peptide or protein is improved by at least 2-fold, in another embodiment of the invention at least 5-fold, and in yet another embodiment of

the method by at least 10-fold over the bioavailability of the bioactive peptide or protein when administered to a subject via transmucosal delivery in the absence or substantial absence of the absorption enhancing composition.

The following examples are intended to provide illustrations of the application of the present invention. The following examples are not intended to completely define or otherwise limit the scope of the invention.

Examples

The peptide exendin-4 (AC2993) is useful as a model for peptides or proteins with iso-electric points that lend themselves (or can be buffered) to have either neutral or positive net charges within the pH range from about 4 to about 7 for optimum transmucosal delivery.

Example 1:

An aqueous pharmaceutical composition was prepared as follows: 0.5% weight by volume of exendin-4; 0.5% weight by volume of poly-L-arginine hydrochloride of average molecular weight 141 kDa; 0.56% weight by volume of monosodium glutamate, monohydrate; 0.72% weight by volume of sodium chloride; hydrochloric acid q.s. to adjust the pH to approximately 4.5; q.s. to 100.0% weight by volume of water.

Example 2:

An aqueous pharmaceutical composition was prepared as follows: 0.5% weight by volume of exendin-4; 0.25% weight by volume of poly-L-arginine hydrochloride of average molecular weight 141 kDa; 0.56% weight by volume of monosodium glutamate, monohydrate; 0.72% weight by volume of sodium chloride; hydrochloric acid q.s. to adjust the pH to approximately 4.5; q.s. to 100.0% weight by volume of water.

Example 3:

An aqueous pharmaceutical composition was prepared as follows: 0.5% weight by volume of exendin-4; 0.5% weight by volume of poly-L-arginine hydrochloride of average molecular weight 141 kDa; 0.56% weight by volume of

monosodium glutamate, monohydrate; 0.72% weight by volume of sodium chloride; 0.5% weight by volume of hydroxypropyl methylcellulose of average molecular weight approximately 86 kDa; hydrochloric acid q.s. to adjust the pH to approximately 4.5; q.s. to 100.0% weight by volume of water.

Example 4:

To evaluate the efficacy of the transmucosal absorption enhancing ability of the cationic polyamino acids of the invention, the aqueous pharmaceutical compositions of Examples 1-3, and a control composition (prepared in the absence of the cationic polyamino acid) were prepared and nasally administered to Cynomolgus monkeys via a spray bottle. As depicted in Figures 1 and 2, the presence of a cationic polyamino acid (poly-L-arginine) showed a significant, concentration dependent effect on transmucosal absorption and bioavailability which was dependent on the concentration of the polyamino acid. More specifically, Figure 1 depicts the bioavailability enhancement (normalized to a 1 μg/kg dose) of three exendin-4 aqueous solutions containing poly-L-arginine with or without hydroxypropyl methylcellulose as compared to a control exendin-4 solution without poly-L-arginine. Figure 2 depicts the area under the plasma curves (AUC) up to 8 hours post-dosing of the exendin-4 solutions relative to the solution affording the highest bioavailability (NF-1). The data show that the AUC of the exendin-4 control solution without poly-L-arginine (NF-4) is approximately one-tenth of that of the solution containing 0.5% poly-L-arginine (NF-1). Thus, the bioavailability is unexpectedly enhanced 10-fold by the poly-L-arginine formulation.

Conclusion

In light of the detailed description of the invention and the examples presented above, it can be appreciated that the several aspects of the invention are achieved.

It is to be understood that the present invention has been described in detail by way of illustration and example in order to acquaint others skilled in the art with the invention, its principles, and its practical application. Particular formulations and processes of the present invention are not limited to the descriptions of the specific embodiments presented, but rather the descriptions and examples should be viewed in terms of the claims that follow and their equivalents. While some of the examples and descriptions above include some conclusions about the way the invention may

function, the inventors do not intend to be bound by those conclusions and functions, but put them forth only as possible explanations.

It is to be further understood that the specific embodiments of the present invention as set forth are not intended as being exhaustive or limiting of the invention, and that many alternatives, modifications, and variations will be apparent to those of ordinary skill in the art in light of the foregoing examples and detailed description. Accordingly, this invention is intended to embrace all such alternatives, modifications, and variations that fall within the spirit and scope of the following claims.

What is claimed is:

1. A pharmaceutical composition for transmucosal administration of a bioactive peptide or protein of interest comprising said bioactive peptide or protein of interest, a cationic polyamino acid, and a compatible buffer, wherein at the pH of the composition said compatible buffer does not cause precipitation of the cationic polyamino acid, and has a mono-anionic or neutral net charge; and

wherein the transmucosal absorption of said bioactive peptide or protein is increased relative the absorption of said bioactive peptide or protein in the absence of said cationic polyamino acid.

2. The composition of claim 1, wherein the pH of said composition is between about pH 4.0 and about pH 6.0.

3. The composition of claim 1, wherein the pH of said composition is between about pH 4.0 and pH 5.0.

4. The composition of claim 1, wherein said compatible buffer is selected from the group consisting of acetic acid, ε-aminocaproic acid or glutamic acid.

5. The composition of claim 1, wherein said compatible buffer comprises glutamic acid.

6. The composition of claim 1, further comprising a tonicifying agent, a viscosity-increasing agent, a bioadhesive agent, a preservative, or any combination thereof.

7. The composition of claim 1, wherein said cationic polyamino acid comprises poly-histidine, poly-arginine, poly-lysine, or any combination thereof.

8. The composition of claim 7, wherein said cationic polyamino acid has an average molecule weight of between about 10 kDa and about 200 kDa.

9. The composition of claim 1, wherein said bioactive peptide or protein is an exendin, an exendin analog, or an exendin derivative.

10. The composition of claim 1, wherein said bioactive peptide or protein is selected from the group consisting of exendin-3, exendin-4, exendin-4 acid, exendin-4 (1-30), exendin-4 (1-30) amide, exendin-4 (1-28), exendin-4 (1-28) amide, ^{14}Leu, ^{25}Phe exendin-4 amide, and ^{14}Leu, ^{25}Phe exendin-4 (1-28) amide.

11. The composition of claim 1, wherein said bioactive peptide or protein is selected from the group consisting of GLP-1, a GLP-1 analog, and a GLP-1 derivative.

12. The composition of claim 1, wherein said bioactive peptide or protein is selected from the group consisting of GLP-1, GLP-1 (7-37), GLP-1(7-36)NH_2, Gly^8 GLP-1(7-37), Ser^{34} GLP-1(7-37) Val^8 GLP-1(7-37) and Val^8 Glu^{22} GLP-1(7-37).

13. The composition of claim 1, wherein said bioactive peptide or protein is selected from the group consisting of PYY peptides, PYY agonists and PYY derivatives.

14. The composition of claim 1, wherein said bioactive peptide is PYY or PYY (3-36).

15. The composition of claim 6, wherein said tonicifying agent is selected from the group consisting of sodium chloride, mannitol, sucrose, glucose and any combination thereof.

16. The composition of claim 6, wherein said viscosity-increasing agent is selected from the group consisting of: hydroxypropyl cellulose, hydroxypropyl methylcellulose, methylcellulose of average molecular weight between about 10 and about 1,500 kDa, starch, gums and any combination thereof.

17. The composition of claim 6, wherein said bioadhesive agent is selected from the group consisting of: carbomer, polycarbophil and any combination thereof.

18. The composition of claim 6, wherein said preservative is selected from the group consisting of phenylethyl alcohol, methylparaben, ethylparaben, propylparaben, butylparaben, chlorbutanol, benzoic acid, sorbic acid, phenol, m-cresol, alcohol, and any combination thereof.

19. The composition of claim 1, wherein said absorption is increased at least 2 fold.

20. The composition of claim 1, wherein said absorption is increased at least 5 fold.

21. The composition of claim 1, wherein said absorption is increased at least 10 fold.

22. A pharmaceutical composition for transmucosal administration of a bioactive peptide or protein of interest comprising about 0.01% to about 5.0% (w/v) of said bioactive peptide or protein of interest; about 0.01% to about 1.0% (w/v) of a cationic polyamino acid having a molecular weight between about 10 kDa and about 200 kDa; and about 0.01% to about 10.0% (w/v) of a compatible buffer, wherein at of between about pH 4.0 and about 5.0, said compatible buffer does not cause precipitation of the cationic polyamino acid, and has a mono-anionic or neutral net charge; and wherein the transmucosal absorption of said bioactive peptide or protein is increased relative the absorption of said bioactive peptide or protein in the absence of said cationic polyamino acid.

23. The composition of claim 22, further comprising between about 0.001% to about 10.0% of a tonicifying agent.

24. The composition of claim 22, further comprising between about 0.001% to about 10.0% of a viscosity-increasing agent.

25. The composition of claim 22, further comprising between about 0.001% to about 10.0% of a bioadhesive agent.

26. The composition of claim 22, further comprising between about 0.001% to about 10.0% of a preservative.

27. A pharmaceutical composition for transmucosal administration comprising about 0.5% (w/v) of exendin-4; about 0.5% (w/v) of poly-arginine having an average molecular weight of about 141 kDa; and about 0.56% monosodium glutamate, monohydrate (w/v) at a pH of about 4.5.

28. The composition of claim 27, wherein said poly-arginine is poly-L-arginine.

29. The composition of claim 27, wherein said composition further comprises a tonicifying agent, a viscosity-increasing agent, a bioadhesive agent, a preservative, or any combination thereof.

30. The composition of claim 27, further comprising about 0.72% sodium chloride (w/v).

31. A pharmaceutical composition for transmucosal administration comprising about 0.5% (w/v) of exendin-4; about 1.0% (w/v) of poly-arginine having an average molecular weight of about 141 kDa; and about 0.56% monosodium glutamate, monohydrate (w/v) at a pH of about 4.5.

32. The composition of claim 31, wherein said poly-arginine is poly-L-arginine.

33. The composition of claims 31, wherein said composition further comprises a tonicifying agent, a viscosity-increasing agent, a bioadhesive agent, a preservative, or any combination thereof.

34. The composition of claim 31, further comprising about 0.72% sodium chloride (w/v).

35. A method for transmucosal administration of a bioactive peptide or protein comprising contacting a mucosal surface for a time sufficient for a therapeutically

effective amount of said bioactive peptide or protein to pass through the mucosal surface, with a composition comprising said bioactive peptide or protein of interest, a cationic polyamino acid, and a compatible buffer, wherein at the pH of the composition, said compatible buffer does not cause precipitation of the cationic polyamino acid, and has a mono-anionic or neutral net charge; and wherein the transmucosal absorption of said bioactive peptide or protein is increased relative the absorption of said bioactive peptide or protein in the absence of said cationic polyamino acid.

36. The method of claim 35, wherein said bioactive protein or peptide is an exendin, GLP-1 or an analog or derivative thereof and said dose is therapeutically effective in lower blood glucose.

37. The method of claim 36, wherein said exendin is selected from the group consisting of exendin-3, exendin-4, exendin-4 acid, exendin-4 (1-30), exendin-4 (1-30) amide, exendin-4 (1-28), exendin-4 (1-28) amide, ^{14}Leu, ^{25}Phe exendin-4 amide, and ^{14}Leu, ^{25}Phe exendin-4 (1-28) amide.

38. The method of claim 36, wherein said GLP-1 is selected from the group consisting of GLP-1, GLP-1 (7-37), GLP-1(7-36)NH_2, Gly^8 GLP-1(7-37), Ser^{34} GLP-1(7-37) Val^8 GLP-1(7-37) and Val^8 Glu^{22} GLP-1(7-37).

39. The method of claim 35, wherein said bioactive protein or peptide is a PYY peptide or an analog or derivative thereof, and said dose is therapeutically effective in food intake, gastric emptying, pancreatic secretion or weight loss.

40. The method of claim 39, wherein said PYY peptide is PYY (3-36)

41. The method of claim 35, wherein said bioactive protein or peptide is an exendin, GLP-1 or an analog or derivative thereof and said dose is effective in causing weight loss.

42. The method of claim 41, wherein said exendin is selected from the group consisting of exendin-3, exendin-4, exendin-4 acid, exendin-4 (1-30), exendin-4 (1-

30) amide, exendin-4 (1-28), exendin-4 (1-28) amide, ^{14}Leu, ^{25}Phe exendin-4 amide, and ^{14}Leu, ^{25}Phe exendin-4 (1-28) amide.

43. The method of claim 41, wherein said GLP-1 is selected from the group consisting of GLP-1, GLP-1 (7-37), GLP-1 (7-36)NH_2, Gly^8 GLP-1(7-37), Ser^{34} GLP-1(7-37) Val^8 GLP-1(7-37) and Val^8 Glu^{22} GLP-1(7-37).

44. A method for transmucosal administration of a bioactive peptide or protein comprising contacting a mucosal surface with a bioactive peptide or protein selected from the group consisting of exendin-3, exendin-4, exendin-4 acid, exendin-4 (1-30), exendin-4 (1-30) amide, exendin-4 (1-28), exendin-4 (1-28) amide, ^{14}Leu, ^{25}Phe exendin-4 amide, and ^{14}Leu, ^{25}Phe exendin-4 (1-28) amide for a time sufficient for a therapeutically effective amount of said bioactive peptide or protein to pass through the mucosal surface, with a composition comprising said bioactive peptide or protein of interest, poly-arginine having an average molecular weight of about 141 kDa; and glutamic acid at a pH of about 4.5; wherein the transmucosal absorption of said bioactive peptide or protein is increased relative the absorption of said bioactive peptide or protein in the absence of said poly-arginine.

45. A method for increasing the bioavailability of a bioactive peptide or protein of interest following transdermal administration comprising, combining said bioactive peptide or protein with a cationic polyamino acid and a compatible buffer, wherein at the pH of the composition, said compatible buffer does not cause precipitation of the cationic polyamino acid, and has a mono-anionic or neutral net charge; wherein the bioavailability of said bioactive peptide or protein is increased relative the bioavailability of said bioactive peptide or protein in the absence of said cationic polyamino acid.

46. The method of claim 45, wherein said bioactive protein or peptide is an exendin, GLP-1, a PYY peptide, or an analog or derivative of an exendin, GLP-1 or a PYY peptide.

47. The method of claim 46, wherein said exendin is selected from the group consisting of exendin-3, exendin-4, exendin-4 acid, exendin-4 (1-30), exendin-4 (1-

30) amide, exendin-4 (1-28), exendin-4 (1-28) amide, ^{14}Leu, ^{25}Phe exendin-4 amide, and ^{14}Leu, ^{25}Phe exendin-4 (1-28) amide.

48. The method of claim 46, wherein said GLP-1 is selected from the group consisting of GLP-1, GLP-1 (7-37), GLP-1(7-36)NH_2, Gly^8 GLP-1(7-37), Ser^{34} GLP-1(7-37) Val^8 GLP-1(7-37) and Val^8 Glu^{22} GLP-1(7-37).

49. The method of claim 46, wherein said PYY peptide is PYY or PYY (3-36).

50. A method for increasing the bioavailability of a bioactive peptide or protein of interest following transdermal administration comprising, combining a bioactive peptide or protein selected from the group consisting of exendin-3, exendin-4, exendin-4 acid, exendin-4 (1-30), exendin-4 (1-30) amide, exendin-4 (1-28), exendin-4 (1-28) amide, ^{14}Leu, ^{25}Phe exendin-4 amide, and ^{14}Leu, ^{25}Phe exendin-4 (1-28) amide; with poly-arginine having an average molecular weight of about 141 kDa, and glutamic acid at a pH of about 4.5; wherein the bioavailability of said bioactive peptide or protein is increased relative the bioavailability of said bioactive peptide or protein in the absence of said poly-arginine.

Figure 1

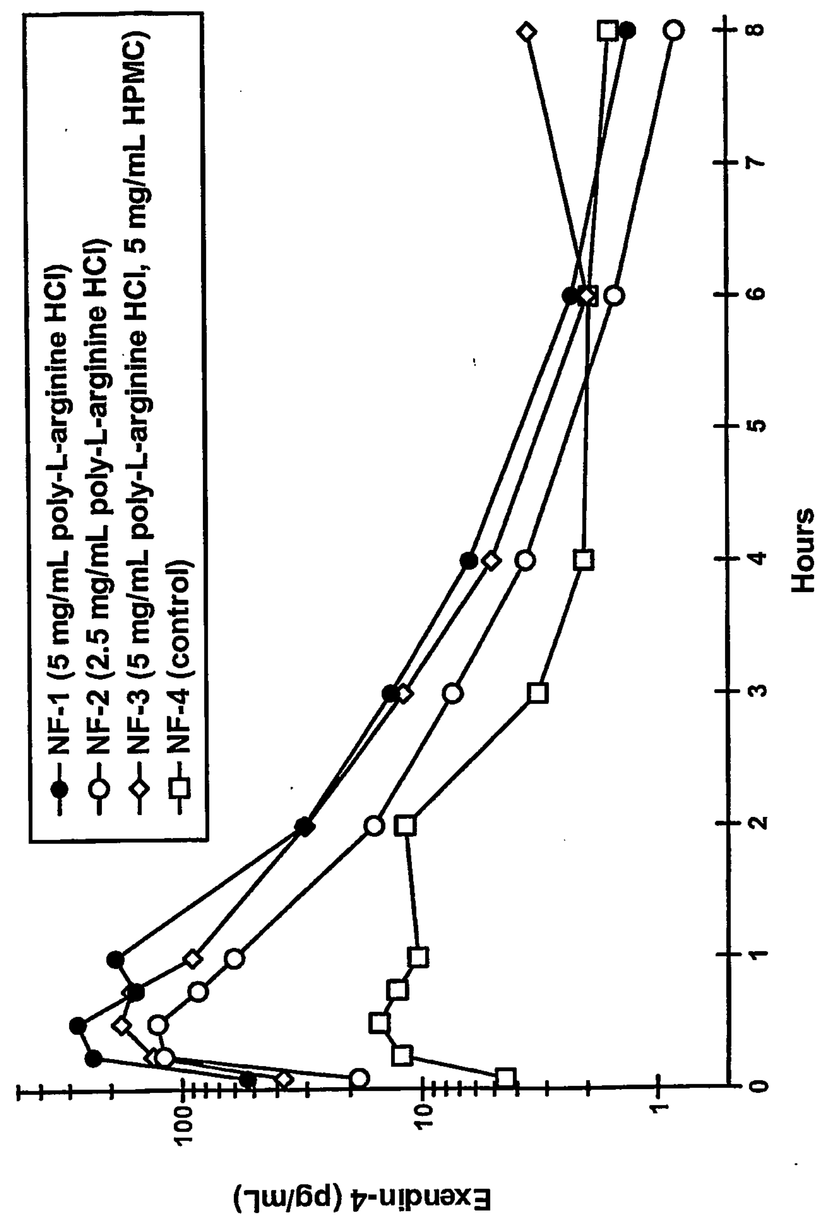

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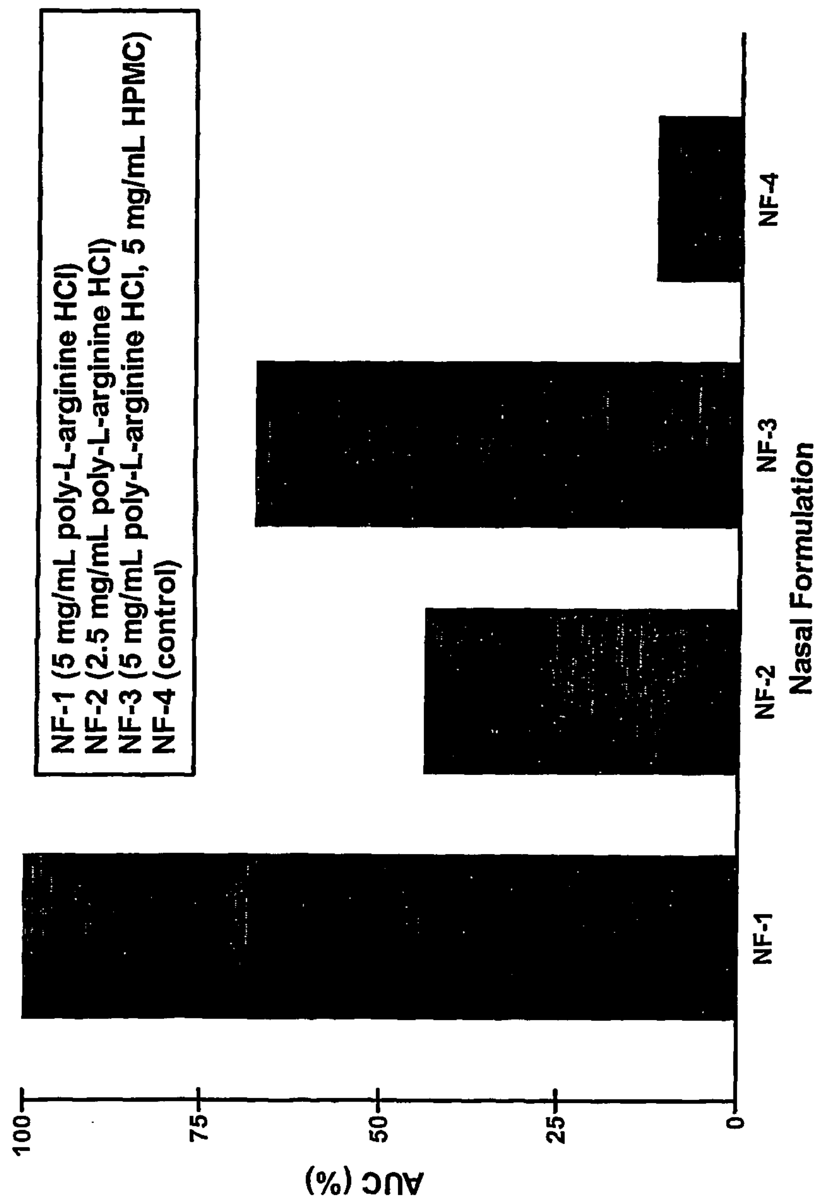
Figure 2



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